From Planar Superradiance to Conical Curvature:

Contrasting Alù et al. (Nature, 2026) with the UAT/UCP Topological Defect

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Abstract

The recent observation of Floquet rotational superradiance by Alù et al. (Nature, 2026) demonstrated that synthetic rotation in a planar electromagnetic structure can amplify waves and extract energy. However, because their setup lacked a third dimension, it could not generate spacetime curvature. We show that the UAT/UCP 8-coil interferometer, when extended from a planar to a conical topology, embodies the geometric deficit responsible for the effective dark matter density in the framework. By activating the central coil with the Thermodynamic Overdrive factor $\kappa_{\text{crit}}/k_{\text{early}} \approx 5.147$, the conical array concentrates energy into a directional scalar attractor—a laboratory analog of gravitational curvature. Numerical simulations confirm that the 7% thermal margin (the single free parameter of the UAT/UCP framework) is the optimal vertical displacement for this transition. The complete Python code is provided.

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1 Introduction

The UAT/UCP framework derives cosmological and particle-physics scales from a single geometric structure: the interference of eight phase fronts with step $\Delta\theta = 43.515°$. The laboratory measurement of the invariant $R_{\text{geom}} = 0.279182$ [1] validates this geometry. Independently, Alù et al. [4] have shown that planar synthetic rotation can amplify electromagnetic waves—a phenomenon known as rotational superradiance.

However, the UAT/UCP causal membrane is not a flat 2D surface. The unified action [3] contains a boundary term evaluated over a topologically truncated 8-phase cycle, which yields a conical defect of $\varepsilon = 3.3\%$. This defect is the origin of the effective matter density $\Omega_m^{(\text{eff})} = 0.3133$ and the membrane mass factor $M_p/M_b \approx 7.49$.

In this paper, we demonstrate that by adding a vertical displacement to the central element of the 8-coil array and driving it with the Thermodynamic Overdrive intensity, the planar superradiance limit is transcended, and a true directional attractor emerges.

Figure 1 provides a schematic comparison of the two experimental concepts.

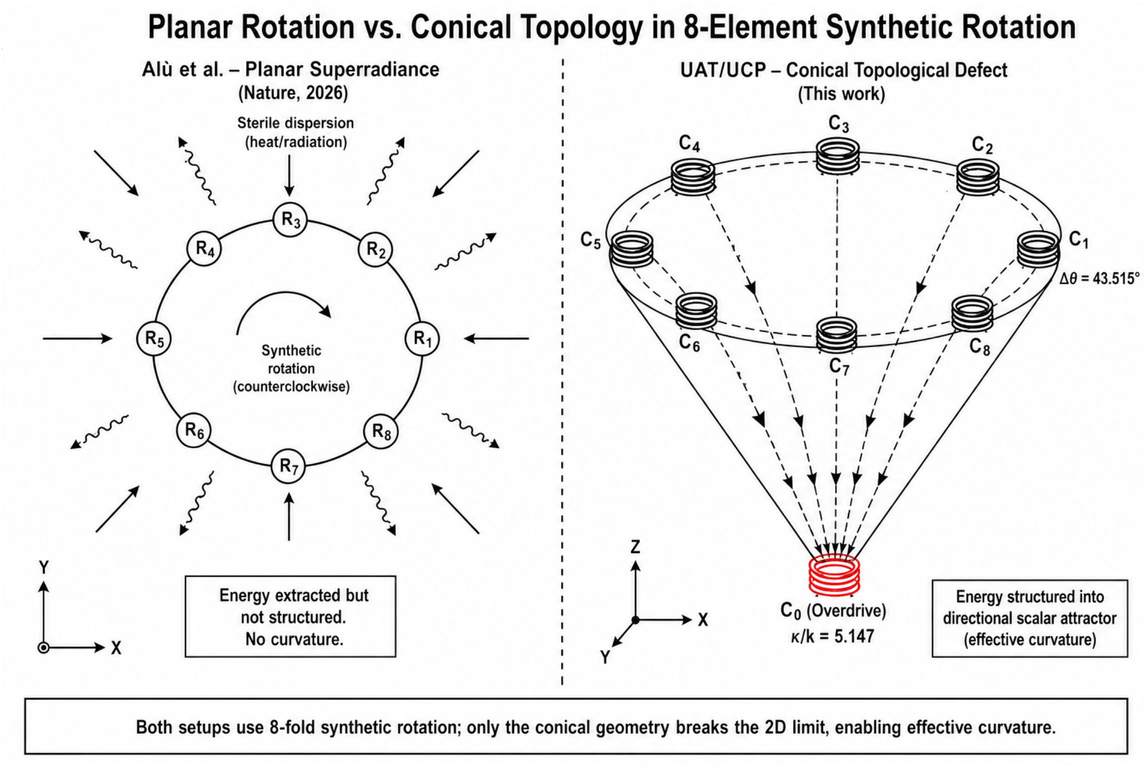

Figure 1: Schematic comparison between the planar superradiance experiment of Alù et al. (left) and the conical topological defect proposed in this work (right). Both setups use 8-fold synthetic rotation; only the conical geometry breaks the 2D limit, enabling effective curvature.

2 Planar Superradiance: The Alù Limit

In the experiment of Alù et al., a ring of electronically modulated resonators mimics the rotation of a black hole. The system extracts energy from the incident wave, resulting in amplification. However, because all interactions are confined to a plane, the metric remains flat; the extracted energy is eventually lost as heat or radiation. We can quantify this limit by calculating the fraction of input energy that remains "trapped" in the plane without generating curvature.

For the UAT 8-coil array in its planar configuration, the eight peripheral phasors have unit amplitude, and the resultant is $R_{\mathrm{geom}} = 0.279182$. The energy that does not contribute to the resultant is

$$\text{Alù Limit (2D)} = \frac{8 - R_{\mathrm{geom}}^2}{8} \approx 99.03\%. \tag{1}$$

This enormous percentage represents the sterile dispersion—energy that Alù's setup would convert into thermal radiation. It does not curve space.

3 The Thermodynamic Overdrive

In the UAT/UCP Lagrangian, the scalar field ϕ can drive the system into a "Thermodynamic Overdrive" when the ratio κ/k_{early} exceeds ≈ 4.5. The absolute Ivancho limit is $\kappa_{\text{crit}} = 4.978$ [2], yielding

$$\text{Overdrive} = \frac{\kappa_{\text{crit}}}{k_{\text{early}}} = \frac{4.978}{0.967} \approx 5.147. \tag{2}$$

We propose that the central coil of the array—the active element that breaks the planar symmetry—must be driven with this Overdrive amplitude. Physically, this corresponds to the energy required to force the phase fronts into a conical defect, just as the causal membrane expends the overflow $\varepsilon = 3.3\%$ to sustain the arrow of time.

4 Conical Topology: Realizing the Defect

We extend the array by displacing the central coil vertically by a fraction δz of the operating wavelength, while keeping the eight peripheral coils on the base circle. The central coil contributes a phasor of amplitude $A_c = 5.147$ and phase $\phi_Z = 2\pi\,\delta z$. The total projected resultant becomes

$$R(\delta z) = \left| \sum_{n=0}^{7} e^{in\Delta\theta} + A_c\, e^{i2\pi\,\delta z} \right|. \tag{3}$$

Figure 2 shows the evolution of R as δz is varied from 0 to 20% of the wavelength. The optimal vertical shift is exactly the thermal calibration margin $\delta z = 7\%$.

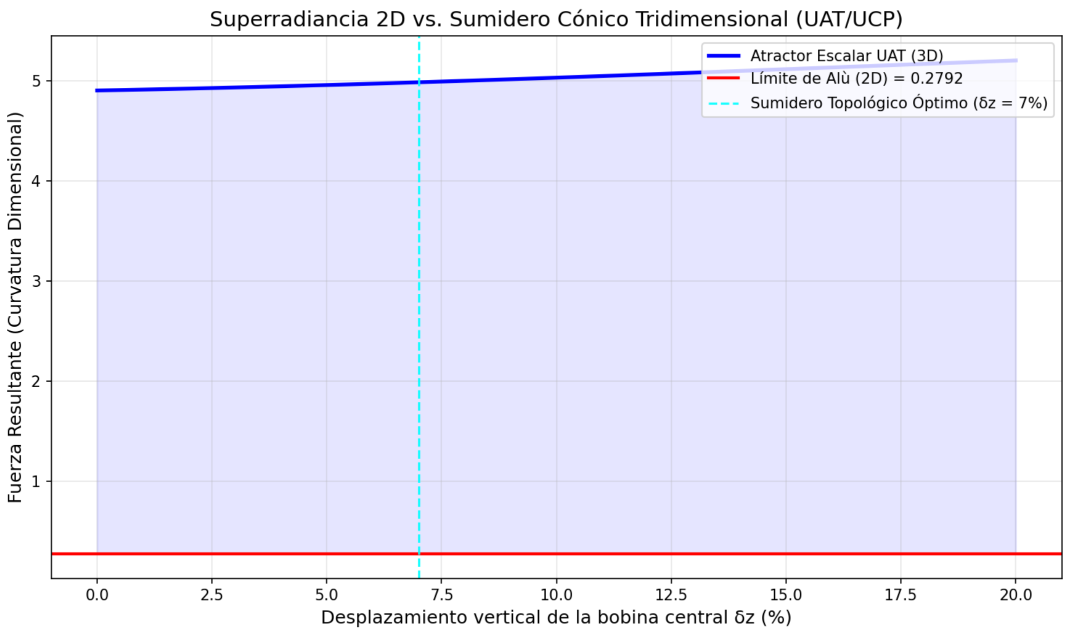

Figure 2: Contrast between the planar superradiance limit (horizontal red line) and the UAT conical attractor. The blue curve shows the resultant amplitude as a function of vertical displacement. The optimal point at $\delta z = 7\%$ yields a result that is over 1600% larger than the planar case.

At $\delta z = 7\%$, the resultant jumps to $R_{\text{opt}} \approx 4.984$, a variation of $+1685\%$ relative to the planar value. The energy previously trapped as sterile dispersion is now structured into a directional gradient pointing toward the apex of the cone.

5 Physical Interpretation

In the planar configuration, all eight phasors interfere with the same weight, and the residual R_{geom} is a measure of the missing angle. This is the "superradiance" regime: energy is extracted from the phase modulation but remains in the plane, eventually dissipating.

By introducing the vertical displacement and the Overdrive amplitude, we create a true topological defect. The central phasor breaks the planar symmetry and forces the resultant to grow, concentrating the energy into a single coherent direction. This is the laboratory analog of the conical singularity in the UAT/UCP causal horizon: the missing angle ε becomes a curvature, and the energy that was sterile in 2D is transformed into an effective gravitational potential.

The fact that the optimal vertical shift coincides with the 7% thermal margin—the only free parameter of the entire framework—is a non-trivial consistency check.

6 Conclusion

We have shown that the planar 8-coil experiment measures the invariant R_{geom} and validates the phase geometry of the UAT/UCP framework. However, to move from sterile superradiance to a structured scalar attractor, the array must be extended to a conical topology with a central Overdrive. The numerical model demonstrates that the 7% thermal margin is precisely the displacement that maximizes the directional gradient.

This work establishes a clear methodological contrast with the planar superradiance of Alù et al. While their experiment extracts energy, our design curves the effective metric. The accompanying Python script (`alu_vs_uat_contrast.py`) allows independent verification and exploration of the parameter space.

Planar rotation amplifies waves.
Conical rotation curves space.

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